Study on Response Function of Organic Liquid Scintillator for High-energy Neutrons

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Liquid organic scintillators, such as the NE213 and BC501A, have been widely used for neutron spectrometry based on time-of-flight (TOF) or unfolding method in the energy region above several MeV. This is because these scintillators have a comparatively high detection efficiency and a good capability to distinguish neutrons and gamma-rays.

Response function of liquid organic scintillators is essential to derive the accurate neutron spectrum. Therefore, many experiments to measure the response function were performed in the incident neutron energies below 100 MeV. Experimental data above 100 MeV, however, are very scarce because of the difficulty to produce the mono-energetic neutron beam in this energy region. The existing Monte Carlo codes, SCINFUL and CECIL, are often used for estimation of the response function instead of the experimental data. These codes are known to reproduce well the response function for incidences below 100 MeV. Unfortunately, the codes are not applicable to the calculation in the higher energy region. To determine the response function for incidences above 100 MeV, some problems remain still unresolved.

In order to meet these requests, a new Monte Carlo code, designated as SCINFUL-QMD, has been developed. In this code, QMD model is employed as a high-energy nuclear reaction model to extend the upper limit of incident neutron energy to 3 GeV. In the comparison with the experimental data up to 800 MeV, the validation of SCINFUL-QMD was confirmed. The results of SCINFUL-QMD agreed with the experimental data better than those of other calculation codes. To obtain more precise predictions, some further modifications are required to estimate the deposition energy and scintillation light in more detail.

In addition, we will plan to perform measurements of the response function of liquid organic scintillator for neutron incidences up to 1 GeV at the Heavy-Ion Medical Accelerator in Chiba (HIMAC) of National Institute of Radiological Sciences (NIRS), Japan. A comparison between our experimental data and SCINFUL-QMD will be shown at the conference.

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